Research Paper

Epidemiological, Clinical, and Diagnostic Characteristics of Tuberculosis in Adolescents

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ABSTRACT
Background:*Adolescents represent a unique population in tuberculosis (TB) epidemiology, with distinct clinical presentations, diagnostic challenges, and risk factors. Despite high TB burden in Bangladesh, data on adolescent TB remain limited.*
Aim of the study:*To evaluate the epidemiological, clinical, and diagnostic characteristics of tuberculosis among adolescents aged 10–19 years and assess treatment outcomes.*
Methods:*A prospective observational study was conducted over one year Shaheed Monsur Ali Medical College and Hospital, Dhaka, Bangladesh. A total of 120 adolescents with clinically and radiologically confirmed TB were enrolled. Demographic, epidemiological, clinical, and diagnostic data were collected. Treatment outcomes were documented. Data were analyzed using descriptive statistics.*
Result:*Among 120 participants, 68 (56.7%) were male and 52 (43.3%) female. Pulmonary TB was predominant (68.3%), while 31.7% had extrapulmonary TB, most commonly lymph node involvement (47.4%). Persistent cough (75.8%), fever (72.5%), and weight loss (68.3%) were frequent. Mantoux test was positive in 74.2%, GeneXpert detected Mycobacterium tuberculosis in 60%, and chest X-ray suggested TB in 77.5%. Nutritional vulnerability was noted in 40.8%. Treatment success (cure or completion) was achieved in 88.3% of cases.*
Conclusion:*Adolescent TB in Bangladesh presents predominantly as pulmonary disease with frequent nonspecific symptoms, posing diagnostic challenges. Chest radiography, Mantoux test, and GeneXpert provide complementary diagnostic value. Favorable treatment outcomes highlight the importance of early detection, adolescent-focused TB programs, and comprehensive management strategies to reduce disease burden and transmission.*
Keywords:*Adolescent tuberculosis, Pulmonary tuberculosis, Extrapulmonary tuberculosis, GeneXpert, Bangladesh, Treatment outcomes.*

I. Introduction

Tuberculosis (TB) is a chronic infectious disease primarily caused by the bacterium Mycobacterium tuberculosis [1].In 2018, an estimated 10 million people developed TB globally, including 5.7 million men, 3.2 million women, and 1.1 million children, highlighting the sustained global burden of the disease [2]. In Bangladesh, tens of thousands of children may develop TB each year, often around 35,000, yet many fewer cases are notified, reflecting substantial under-diagnosis and reporting gaps [3]. TB is transmitted through airborne particles released when an infected individual coughs, sneezes, or speaks. Although TB primarily affects the lungs, it may also involve extrapulmonary sites such as lymph nodes, bones, kidneys, and the meninges [4]. The continued persistence of TB reflects social inequities, poverty, malnutrition, weak health systems, and delayed case detection, particularly in low- and middle-income countries [5]. Adolescents, defined as individuals aged 10–19 years, constitute a distinct population in TB epidemiology due to their unique clinical manifestations, diagnostic challenges, and exposure patterns, which differ from those of younger children and adults. Clinically, adolescent TB often presents with extrapulmonary manifestations, including lymphadenitis and pleuritis, and may be complicated by co-morbidities such as malnutrition and HIV infection. Diagnostic challenges arise from nonspecific symptoms and the limited sensitivity of conventional diagnostic tests. Advanced diagnostic tools such as chest radiography and molecular assays are increasingly utilized to improve detection rates [6]. Limited access to these diagnostic facilities, particularly in low-resource settings, often results in delayed diagnosis and treatment initiation.The transition from childhood to adulthood involves hormonal, immunological, and behavioral changes that can influence susceptibility to TB infection and disease

progression. Pubertal immune modulation may increase the risk of reactivation of latent TB infection acquired earlier in life [6]. Adolescents are therefore at increased risk of developing TB due to a combination of biological, environmental, and social factors. Biologically, immune maturation during adolescence may lead to variable host responses to Mycobacterium tuberculosis [7]. Environmental determinants such as overcrowded housing, poor ventilation, and exposure to indoor air pollution further increase vulnerability, especially in disadvantaged households [8]. Additionally, adolescents living in or originating from high TB-burden countries experience higher exposure risks due to ongoing community transmission [9]. Migration, rapid urbanization, and school-based exposure have been identified as important contributors to TB transmission among adolescents in endemic regions.Stigma and fear of social exclusion may discourage adolescents from seeking timely medical evaluation, prolonging infectious periods and facilitating continued community transmission [10]. The psychosocial burden of TB during adolescence can have long-term effects on mental well-being and social development. Adolescents are also more likely to transmit TB because of increased social interactions, making this age group a critical target for TB control strategies [11]. This study aimed to examine the epidemiological, clinical, and diagnostic characteristics of tuberculosis in adolescents, focusing on disease prevalence, common clinical features, and the effectiveness of diagnostic methods.

II. Methodology & Materials

This study was conducted at theDepartment of Paediatrics, Shaheed Monsur Ali Medical College and Hospital, Dhaka, Bangladesh, over a period of one year, from January 2022 to December 2022. The study focused on adolescent patients aged 10–19 years who were clinically and radiologically diagnosed with tuberculosis (TB). A total of 120 patients fulfilling the inclusion criteria were selected using a purposive sampling method.

Inclusion Criteria

- Adolescents aged 10–19 years.
- Patients diagnosed as pulmonary or extrapulmonary tuberculosis based on clinical, radiological, or microbiological evidence.
- Patients or guardians who provided informed consent for participation.

Exclusion Criteria

- Patients with previous anti-tuberculosis treatment or relapse cases.
- Patients with HIV infection, malignancy, or severe immunosuppressive conditions.
- Individuals unwilling to participate in the study.

Data Collection

Data were obtained through structured interviews, physical examination, and review of hospital records. Information collected included demographic data (age, gender, residence, and socio-economic status), epidemiological factors (history of contact with TB patients, BCG vaccination, nutritional status, and smoking exposure), clinical presentations, type and site of TB involvement, and diagnostic parameters (Mantoux test, sputum smear microscopy, GeneXpert results, chest radiography, and ESR level). Treatment outcomes were also documented.

Statistical Analysis

All data were entered and analyzed using SPSS software (version 26.0). Categorical variables were presented as frequency and percentage, while continuous variables were expressed as mean ± standard deviation (SD) to summarize the findings in a descriptive manner.

III. Result

Among 120 adolescents with tuberculosis, 48.33% were aged 14–16 years, 26.67% were 10–13 years, and 25.00% were 17–19 years. Males predominated (56.67%) over females (43.33%). A majority lived in urban areas (61.67%), while 38.33% were from rural settings. Socio-economically, 57.50% belonged to low-income households, 31.67% to middle-income, and 10.83% to high-income families. (Table1).60% reported a history of contact with a tuberculosis patient. BCG vaccination scars were present in 70.00% and absent in 30.00%. Nutritional assessment revealed 50.83% had normal BMI, 40.83% were underweight, and 8.33% were overweight. Smoking or exposure to smoke was reported in 23.33% of participants (Table2). Persistent cough >2 weeks was observed in 75.83% of adolescents, fever in 72.50%, and weight loss in 68.33%. Fatigue or malaise occurred in 58.33%, night sweats in 54.17%, chest pain in 35.83%, lymph node swelling in 30.83%, and hemoptysis in 18.33%(Table3). Pulmonary TB was the most common form, affecting 68.33% of adolescents,

while 31.67% had extrapulmonary TB. Among the 38 extrapulmonary cases, lymph nodes were involved in 47.37%, pleura in 26.32%, bones or joints in 15.79%, and meninges in 10.53%(Table4).Diagnostic testing showed a positive Mantoux test in 74.17%, sputum smear positivity in 48.33%, and GeneXpert detection of MTB in 60.00%. Chest X-ray suggestive of TB was observed in 77.50%, and elevated ESR (>40 mm/hr) in 65.83%(Table5).67.50% were cured, and 20.83% completed treatment successfully. Treatment default occurred in 5.00% of cases, while 2.50% experienced treatment failure. Mortality was observed in 4.17% of participants(Table6).

Table 1: Demographic Characteristics of Adolescents with Tuberculosis (N = 120)

Variable	Frequency (n)	Percentage (%)
Age group (years)		
10–13 years	32	26.67
14–16 years	58	48.33
17–19 years	30	25.00
Gender		
Male	68	56.67
Female	52	43.33
Residence		
Urban	74	61.67
Rural	46	38.33
Socio-economic status		
Low income	69	57.50
Middle income	38	31.67
High income	13	10.83

Table 2: Epidemiological Characteristics of the Study Population (N = 120)

Variable	Frequency (n)	Percentage (%)
History of contact with TB patient		
Yes	72	60.00
No	48	40.00
BCG vaccination scar		
Present	84	70.00
Absent	36	30.00
Nutritional status (BMI percentile)		
Underweight (<5th)	49	40.83
Normal (5th–85th)	61	50.83
Overweight (>85th)	10	8.33
Smoking/exposure to smoke		
Yes	28	23.33
No	92	76.67

Table 3: Clinical Presentations of Tuberculosis in Adolescents (N = 120)

Symptom/Sign	Frequency (n)	Percentage (%)
Persistent cough (>2 weeks)	91	75.83
Fever	87	72.50
Weight loss	82	68.33
Night sweats	65	54.17
Hemoptysis	22	18.33
Chest pain	43	35.83
Lymph node swelling	37	30.83
Fatigue/malaise	70	58.33

Table 4: Distribution of Tuberculosis Type and Site (N = 120)

Type/Site	Frequency (n)	Percentage (%)
Type of TB		
Pulmonary	82	68.33
Extrapulmonary	38	31.67
Site of extrapulmonary TB (n=38)		
Lymph node TB	18	47.37
Pleural TB	10	26.32
Bone/joint TB	6	15.79
Meningeal TB	4	10.53

Table 5: Diagnostic Characteristics of Adolescents with Tuberculosis (N = 120)

Diagnostic Parameter	Positive		Negative	
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Mantoux test (≥10 mm)	89	74.17	31	25.83
Sputum smear (AFB positive)	58	48.33	62	51.67
GeneXpert (MTB detected)	72	60.00	48	40.00
Chest X-ray suggestive of TB	93	77.50	27	22.50
ESR > 40 mm/hr	79	65.83	41	34.17

Table 6: Treatment Outcome among the Study Population (N = 120)

Treatment Outcome	Frequency (n)	Percentage (%)
Cured	81	67.50
Treatment completed	25	20.83
Defaulted	6	5.00
Treatment failure	3	2.50
Died	5	4.17

IV. Discussion

Tuberculosis in adolescents constitutes a distinct clinical and epidemiological entity, marked by transitional disease patterns, heterogeneous clinical features, and diagnostic characteristics that bridge childhood and adult tuberculosis [12].In this study, tuberculosis was most frequently observed in adolescents aged 14–16 years (48.33%), followed by those aged 10–13 years (26.67%) and 17–19 years (25.00%), indicating that mid-adolescence represents a peak risk period [13]. A male predominance was noted, with males accounting for 56.67% of cases compared to 43.33% females, a pattern consistent with reports from other high-burden settings where adolescent males demonstrate higher exposure and delayed health-seeking behavior [14].Urban residents constituted 61.67% of cases, exceeding rural adolescents (38.33%), reflecting increased transmission in densely populated environments. Additionally, a majority of patients belonged to low socioeconomic groups (57.50%), reinforcing the well-established association between tuberculosis and poverty, as documented in previous epidemiological studies [15].A history of contact with a tuberculosis patient was reported by 60.00% of adolescents, highlighting the critical role of close and household exposure in disease transmission, similar to findings reported by Marais et al. [16].The presence of a BCG vaccination scar in 70.00% of cases indicates high vaccine coverage; however, this aligns with existing evidence that BCG offers limited protection against pulmonary tuberculosis during adolescence [17]. Undernutrition was observed in 40.83% of patients, emphasizing malnutrition as a major predisposing factor for disease progression, consistent with prior studies [18].Exposure to active or passive smoking was noted in 23.33% of cases, a recognized risk factor for tuberculosis in adolescents [19].Persistent cough lasting more than two weeks was the most common symptom, reported by 75.83% of adolescents, followed by fever (72.50%) and weight loss (68.33%). Night sweats were present in 54.17%, while fatigue or malaise affected 58.33% of cases. These symptom patterns closely resemble adult-type pulmonary tuberculosis, supporting observations that adolescents present with clinical features similar to adults rather than children [20].Among extrapulmonary cases, lymph node involvement was the most frequent (47.37%), followed by pleural tuberculosis (26.32%), bone and joint involvement (15.79%), and meningeal tuberculosis (10.53%). This pattern mirrors previously reported distributions of extrapulmonary tuberculosis in adolescents [16].Chest radiographic findings suggestive of tuberculosis were present in 77.50% of adolescents, while Mantoux test positivity was observed in 74.17%. Sputum smear microscopy was positive in 48.33% of cases, whereas GeneXpert detected Mycobacterium tuberculosis in 60.00%, supporting the superior diagnostic yield of molecular methods in adolescents, particularly in smear-negative disease [21].Favorable treatment outcomes were achieved in the majority of adolescents, with cure documented in 67.50% and treatment completion in 20.83% of cases. Nevertheless, unfavorable outcomes persisted, including default in 5.00%, treatment failure in 2.50%, and mortality in 4.17%. These proportions are comparable to adolescent TB outcome data from other high-burden countries, where cure and completion rates exceed 80% but residual default and mortality remain important public health concerns [22].

Limitations of the study: This study was conducted at a single tertiary hospital, limiting the generalizability of the findings to the broader adolescent population. The purposive sampling method may have introduced selection bias, and reliance on hospital records could have resulted in incomplete epidemiological data. HIV-positive and previously treated TB cases were excluded, potentially underestimating the disease burden. Additionally, advanced diagnostic modalities, such as CT scans or culture-based confirmation, were not routinely employed, which may have affected the accuracy of extrapulmonary TB detection.

V.   Conclusion

This study highlights the distinct epidemiological, clinical, and diagnostic characteristics of tuberculosis among adolescents in Bangladesh. Pulmonary TB predominated, though a substantial proportion presented with extrapulmonary manifestations, particularly lymph node involvement. Common clinical features included persistent cough, fever, weight loss, and night sweats, underscoring the nonspecific symptomatology that challenges timely diagnosis. Diagnostic evaluation revealed that chest radiography, Mantoux test, and GeneXpert assay provided complementary sensitivity for detecting TB in this age group. Despite the high burden of disease and nutritional vulnerabilities, treatment outcomes were largely favorable, with over two-thirds achieving cure. These findings emphasize the need for targeted adolescent-focused TB screening, early detection, and comprehensive management strategies to reduce morbidity and transmission.

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